WNaN Proposers' Day

0800-0900	Registration	
0900-0930	WNaN Overview	Preston Marshall, PM WNaN
0930-0940	MTO Filter Program	John Evans, PM
0940-1020	WNaN Overview	Steve Griggs, PM WNaN
1020-1035	CBMANET Program Overview	Chris Ramming, PM CBMANET
1035-1100	BREAK	
1100-1115	MNM Program Overview	Steve Griggs, PM MNM
1115-1200	CN, DTN, XG Program	Preston Marshall, PM CN, DTN, XG
1200-1300	Lunch	Poster Session
1300-1330	Q&A Session	
1330-1335	Harry Lee	SDRC
1335-1340	Ashu Sabharwal	Rice University
1340-1345	David Davies	Order One Networks
1345-1350	Eric Munro	Maxim Integrated Products
1350-1355	Beau Beck	Airgo Networks
1355-1400	David Love	Purdue University
1400-1405	Jim Webster	BBN
1405-1410	Gary Minden	University of Kansas
1410-1415	Babak Daneshard	Silvus Communications
1415-1420	Phil Rezin	Midwest Microwave
1420-1425	Mike Bajura	USC Info Science Inst
1415-1430	Closing Remarks	Preston Marshall & Steve Griggs

Wireless-Network After Next (W-NAN)

"Making Network Centric Accessible for the Warfighter"

Proposers' Day Presentation

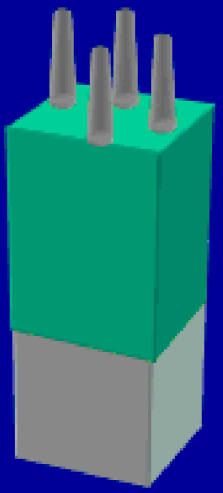
Preston Marshall
Stephen Griggs

15 Sep 05

Defense Advanced Research Projects Agency
Advanced Technology Office

Today's Topics

- The Problem, and the New Technology Philosophy
- The DARPA Technology Approach
- Specific Enabling Technology
- Proposed Program Structure



Enabling the Transition from Robust Radios to Robust Networks

How to Reconcile/Leverage Visions of Wireless Strategies

Commercial World

- Ultra-Low Cost, Disposable
- Multiple Low-Cost ASICs
- Mission Specific Layers
- Multi-Band
- Low Energy Focused (RIM Blackberry Philosophy)
- Infrastructure Focused

Sophisticated SDRs

- Costly, Long Amortization
- Reprogrammable FPGA/GPP
- Core IP Layer for Everything
- Wideband
- High Energy
- Less Infrastructure

How Do We Pick Best from Each?

Analog Impact Technology Impact on the Network Vision

- Analog Capability Drives Radio Cost
  - Digital will be Handled by Moore's Law
- High Cost Leads to Low Density
  - Low Density Stresses Radio Range, thus Cost
- Networking Not Viable as Primary Connectivity Without Suitable Density
  - Forces Higher Costs and Less Density!
- Current Networking Technology Accentuates Hardware Weaknesses, Not Mitigates Them

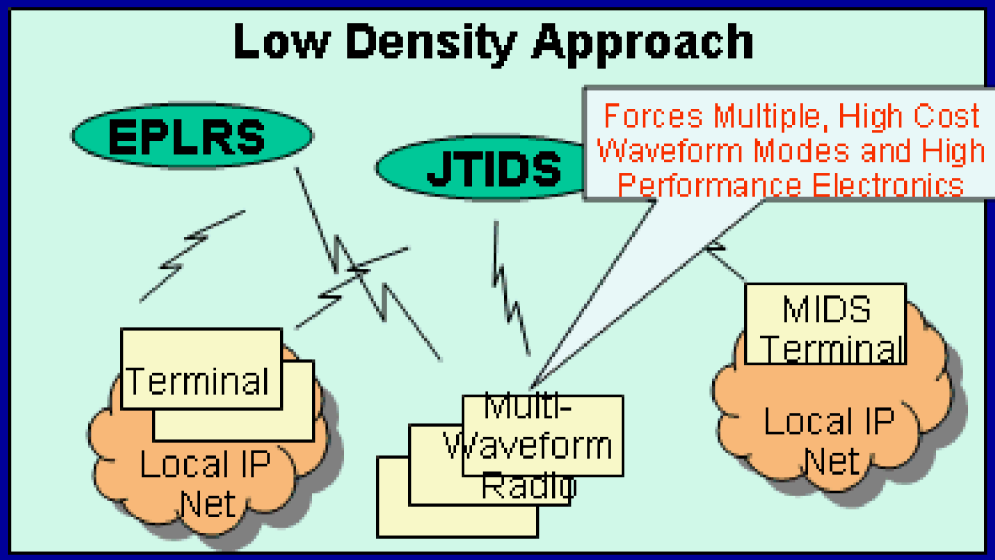
Overall Program Objectives
(Phase 1 through Completion)

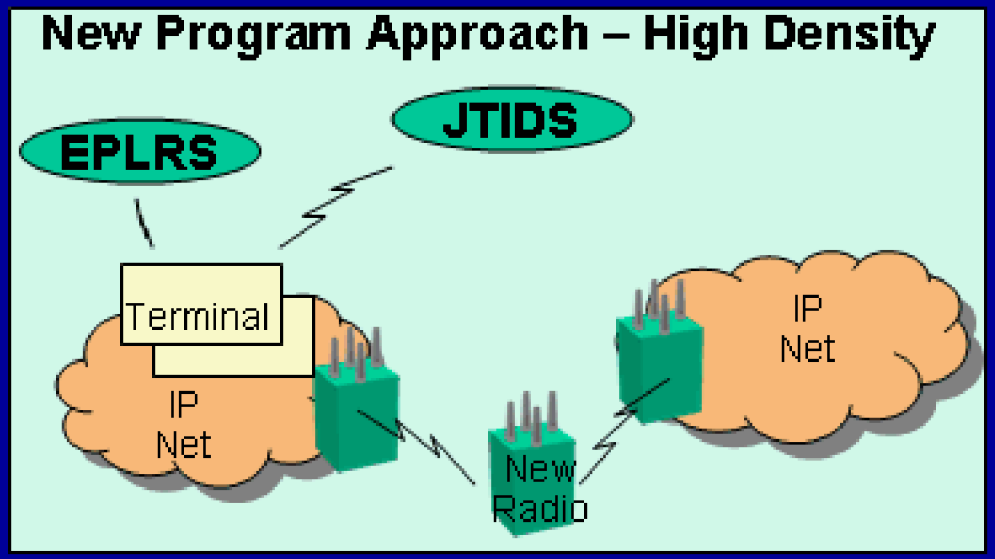
- Develop a Purpose Built Military Network Radio based on Commercial Parts, Lines, and Processes
  - Working, Form Factor Product in Phase 1
- Network-focussed End-to-End Military Communications Model
- Develop Network Capability that Adapts to Mitigate Hardware Shortfalls, and Implement Essential Military Functions
- Develop Network Capability To Integrate 1,000's to 100,000's of radios into one effective and efficient Network
- Adaptation Mechanism to Leverage Successful elements of DARPA Programs
  - MnM, XG, CBMANET and MEMs Technology
- Battalion Sized Demonstration

More Capable, 99% Cost and Weight reduction …, Every Soldier to Any Place

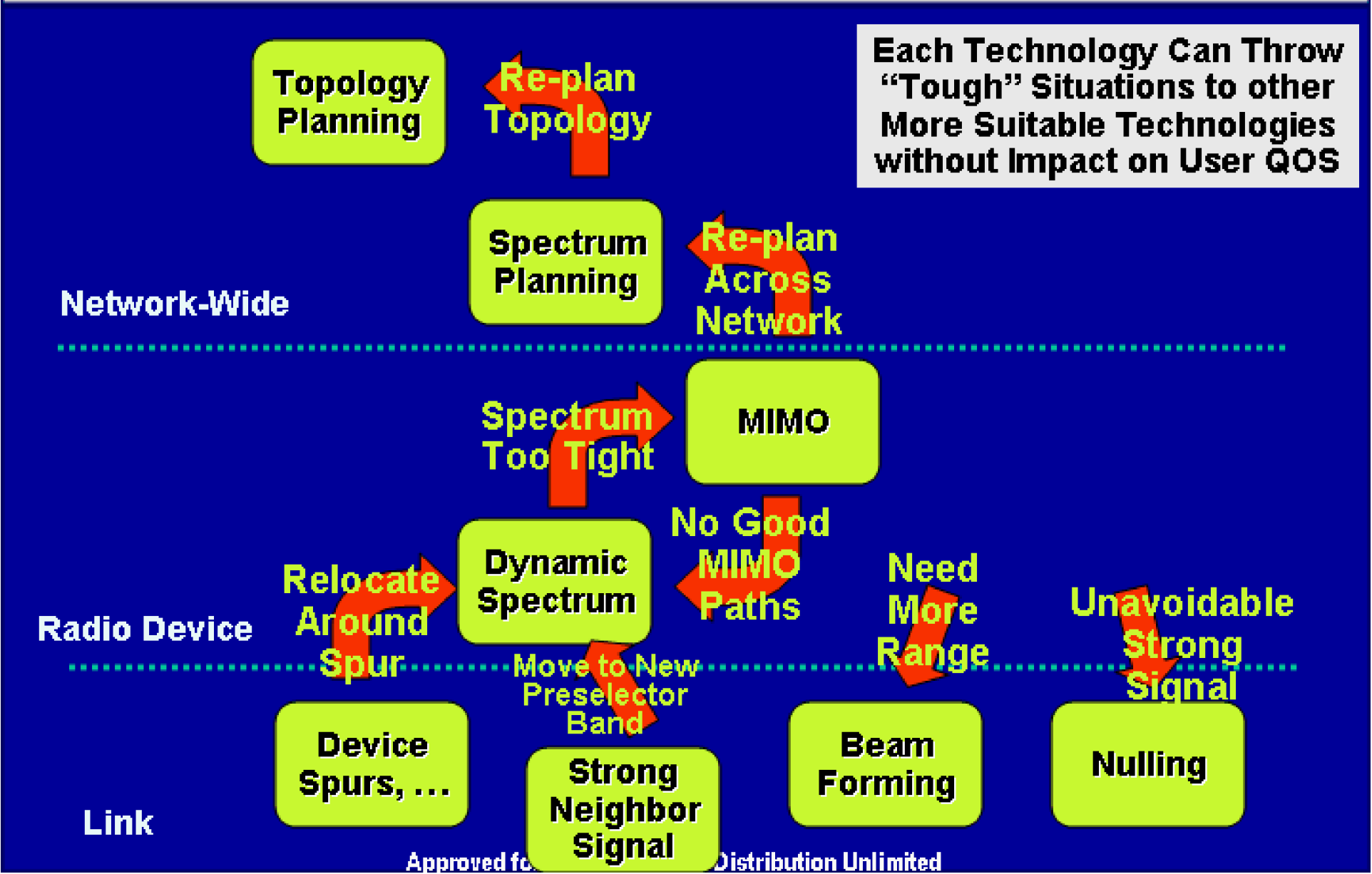
Philosophic Transition to Density Rather than Range

- Transition from End to End to Meshed Network Connectivity
  - Network Takes Responsibility for Delivery
- Use IP Linkage to Avoid Need for All Nodes to Reach All Platforms
  - Network Provides Range and Reliability
- Interoperate at Network (At IP, Not Physical) Layer with JTIDS, SINCGARS, EPLRS, …
- Use Global Network to Resolve Local Shortcomings
- Not Your Grandfather's NxN Gateway – Everyone to IP

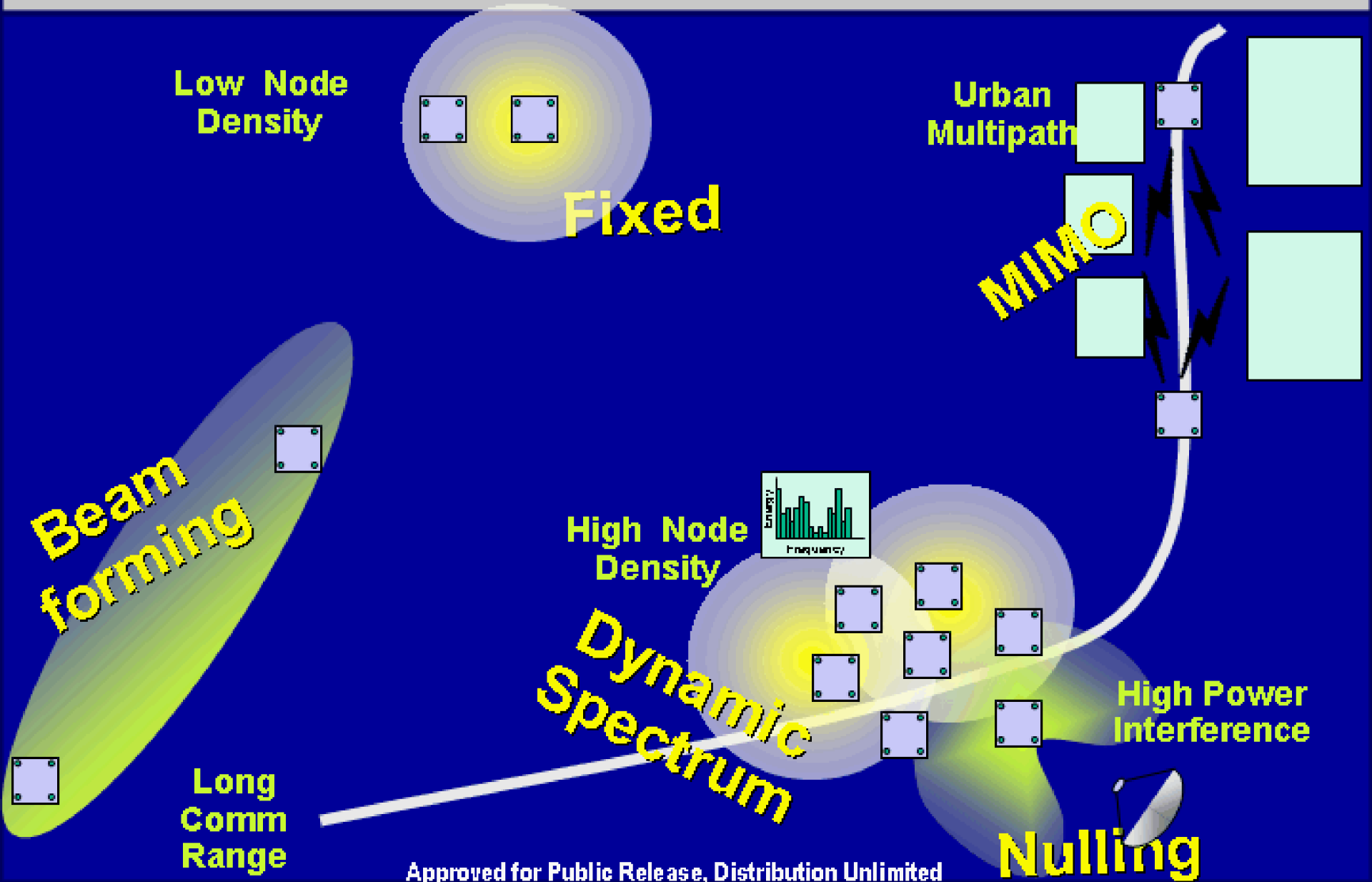




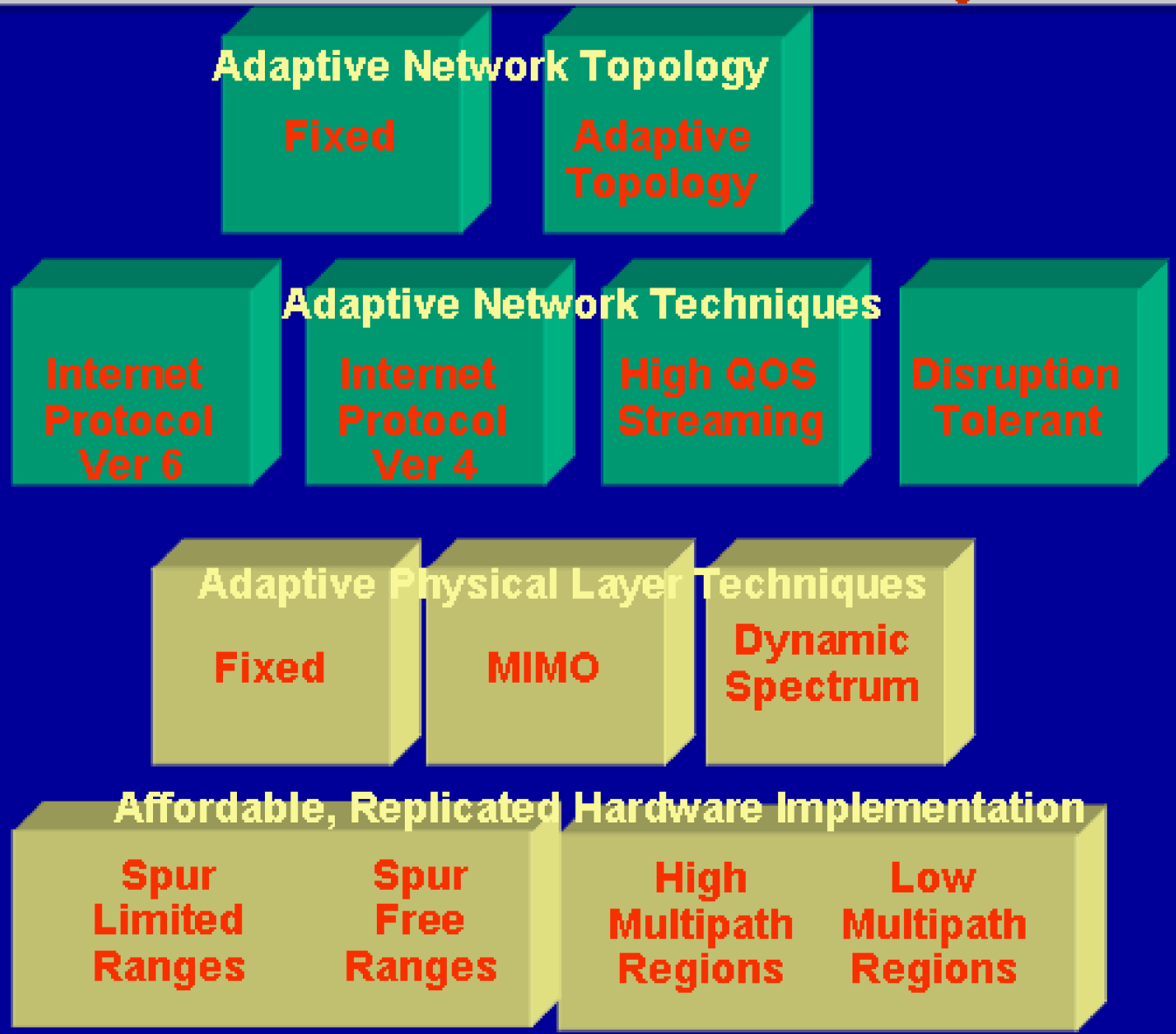
Adaptive Radio Avoids Solving All Problems Itself



Aware and Adaptive Behaviors



Key to Low Cost/High QOS is Interactive Layers

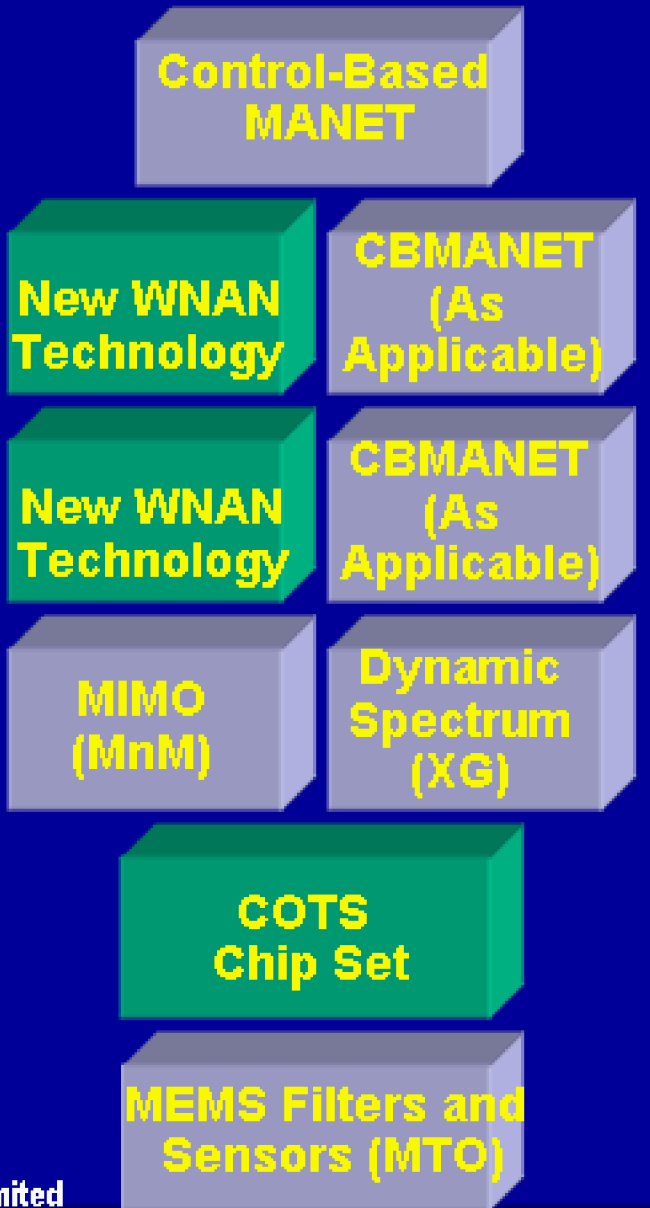


What We Need to Do

- Develop the Technology to:
  - Adapt Network in order to Operate Radios with 20 db Lower SFDR and Linearity at the Same Performance Levels
    - Existing Programs Provide toolkit for the Physical Layer, but Have no Network to Exploit the Opportunities
  - Scale our Understanding to Ultra-Large Mobile Networks
  - Extend Concept of Packet Networks to Directly Implement Broadcast and Streaming Service that Are the Basis of Tactical operation
    - Operate Multiple Network Technologies Simultaneously to Meet Each Mission QOS Need
- Achieve:
  - 100 Time Reduction in Network Radio Cost ($500 to 1000 per 4 Channel Radio)
  - 10 Time Reduction in Network Area Coverage Cost
  - 100 Times Increase in Demonstrated and Objective Network Scale (1,000's/100,000's)
  - 6 times higher Goodput/Throughput Ratio Required to support Broadcast/Netted Voice/Video

The DARPA WNAN Network & Radio

- Optimizing Layer
  - "Looks Through" Lower Layers to Make Globally Optimizing Decisions
- Topology Layer
  - Makes the Network Topology Achievable by the Radios. Plans Network Around Spectrum, Power, Channel, …
- Network Layer
  - Multiple, Unique Networks Optimized for Stream (Voice and Video), Broadcast (GBS-Like) and Packet Services
- MAC Layer
  - Adaptive Spectrum, MIMO, and Beamforming Modes
- PHY Layer
  - Commercial Component-Based, $1,000 Range
  - Standard RF Slice Widely Replicated



Existing Program Technology

Proposed New Program Technology

How Do We Do This?

- Cost Reduction
  - Fundamental Change in Approach Requiring Ever Higher Performance
  - We Can Adapt Around Most Analog Weaknesses
- High Confidence "Dial Tone"
  - Proliferated, Low Cost, and Expendable
  - Clustered RF Units That Can be Baseline, MIMO, or Beam-formed
- Enable Network Centric Warfare
  - Integrate MIMO, XG and LPD modes

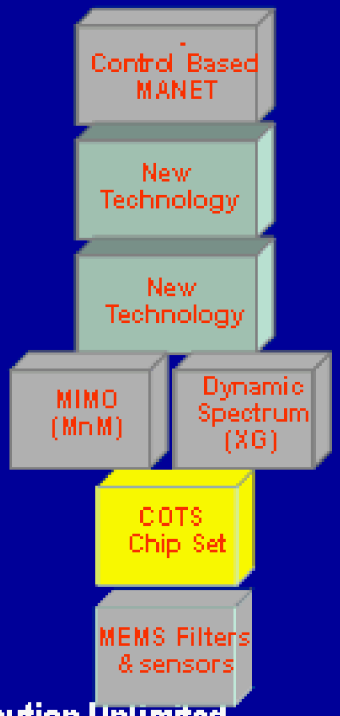
New Technology , Integrated Technology, Plus New Philosophy to Work Around "Defects", Not Spend to Eliminate them

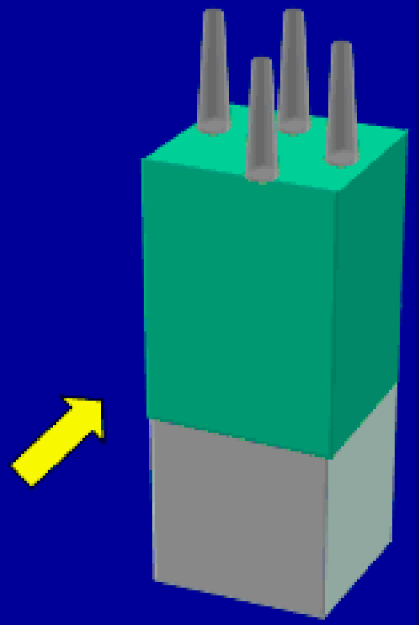
Hardware Platform

- Single RF Processing Slice Replicated to form 1, 2 and 4 channel MIMO/XG/ Beamforming Capable Radios
- Reverse Standard ATO Approach
  - Build Early H/W and Incrementally Add Network Capability
  - Have Early Demonstrator of DARPA Philosophy and Technology
- Develop Prototypes Using Available Commercial Chips
- Assume Contribution from MEMs Filter Program

Frequency	900 MHz to 6 GHz
Power	36 dBm
SFDR	60 dB
IP3	? dBm
Peak	10 Mbps

GPS Access Interleaved by Connectionless Networking Digital Post Processing





Every Tree a Cell Tower

- Use Expendable Radios as Temporary "Cell Towers"
- Small Propellant to "Launch" into Trees, Buildings, Balconies,…
- Objective:
  - 8 Hours Operations
  - 200KBPS Aggregate
  - Equivalent to 10 Cell Channels
- Cost Less Than Buying Cell "minutes" in the US
- Pure Router, so Needs no Message Decryption
- Or, Inductively Couple to Power Line (with Battery for Outage) For Temporary Infrastructure

Utilize More Network Models

TODAY'S!

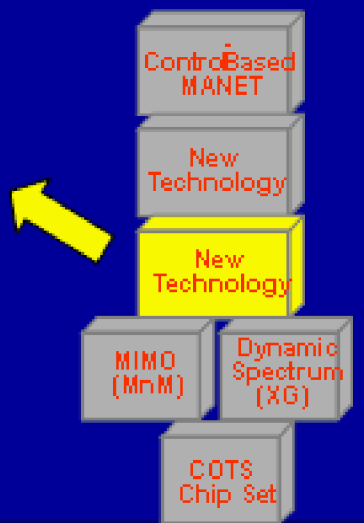
- Application
- Connectionless Transport Layer
- Connection Transport Layer
- Connectionless Network Layer
- Media Access
- Physical

Assumption:
You can create a High Service Quality Connection-Oriented Service on top of a connectionless network Layer

Issues:
- Poor QOS in high demand channels,
- Correlated Demand,
- IP Overhead on Every Packet!!!

Network Centric

- Application
- Connectionless Transport Layer
- Connection Transport Layer
- Connectionless Network Layer
- Connection Network Layer
- Media Access
- Physical

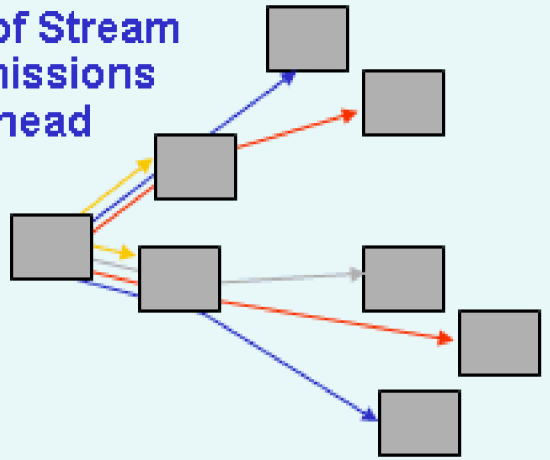


Stream Network Service

- Network centric Warfare will Transfer Traditional Analog Services to Networks
  - Voice, Combat Nets, Video, …
- Internet Packet Model Poor in Delivery Efficiency of these Services
  - No Intelligent Multicast
  - Header Overhead on Each Packet
  - Random Effects on Delivery (Jitter, loss, …)
- Bandwidth Savings:
  - 3 Times Peak Usage reduction
  - 2 Times Usage reduction
  - 1.8 times "Overprovision" reduction
  - 4 Times in 5 hop, video distribution to 250 Subscribers (wired or wireless)

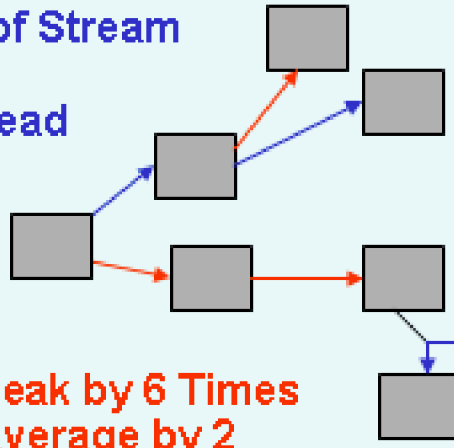
Internet VOIP Model

- 7 Copies of Stream
- 12 Transmissions
- 25% Overhead



DARPA Model

- 2 Copies of Stream
- 6 "Hops"
- 3% Overhead

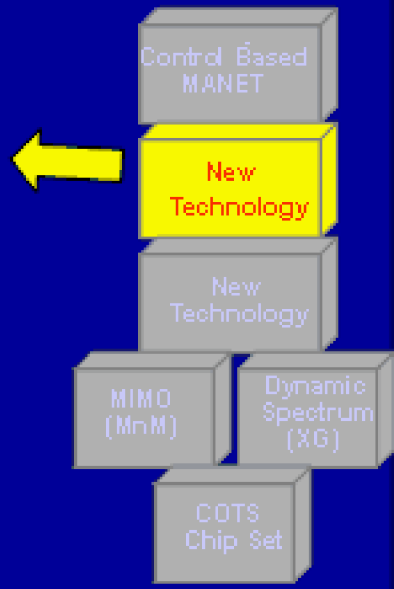


Both Radios Receive the Same Transmissions

- Reduces Peak by 6 Times
- Reduces Average by 2

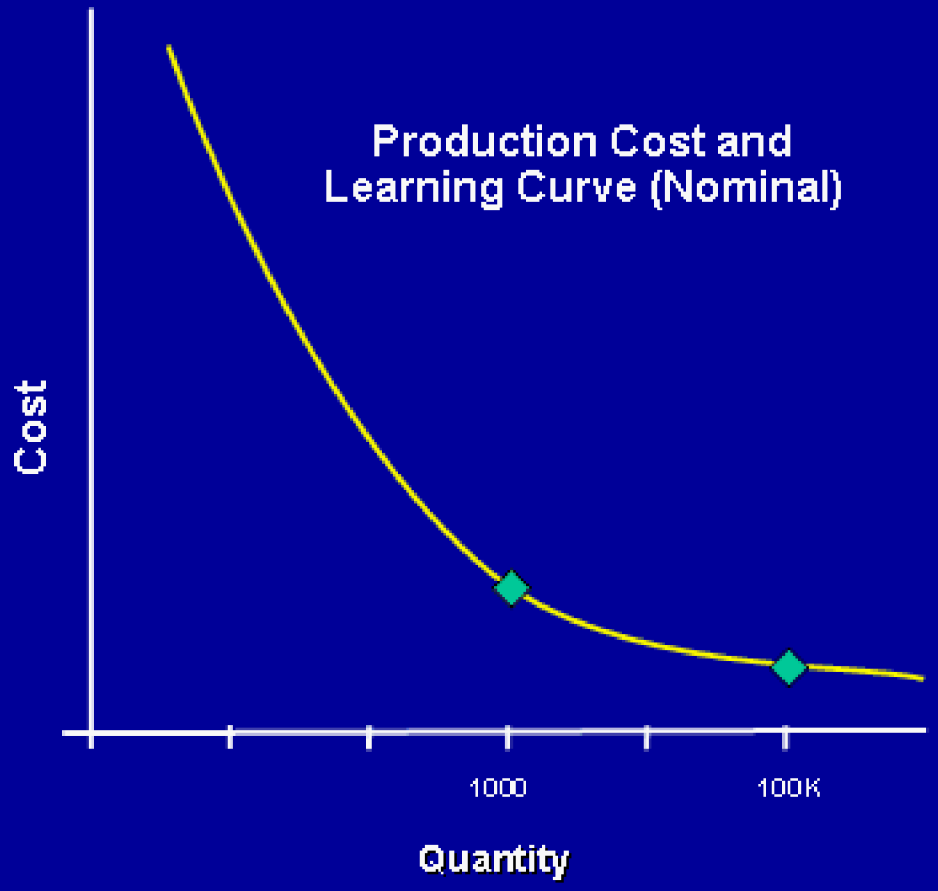
Topology

- Develop a New Network Function –Deciding the Network Topology
  - Today – Network Topology is Whatever Links Say it Is
  - Routers Use What they Get, Not What they Need!
- Objective
  - Have Network Use Topology to Allocate Resources that Interact Between Radios
    - Spectrum, Interference, Routing Responsibility, Battery Power, MIMO vs. Single Channel…
  - Locally Solves Interactions
- Typical Actions:
  - Reduces Certain Radios Bandwidth
  - Forces Frequency Moves
  - Directs Use of MIMO to Resolve Spectrum Shortages
  - Changes Routing to Reduce Load on Low Energy Devices, …



Program Metrics

- Build & demo wireless nodes:
  - 4 RF channels/node
  - Inexpensive RF circuits
  - Shortfalls of the PHY layer can be mitigated at the network layer
- Traceable to $500 unit cost in quantities of 100K, excluding NRE
  - Detailed production cost & learning curve estimates



Questions?